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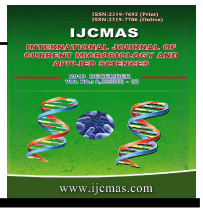

Original Research Article

Antimicrobial activity of extracts of *Jatropha curcas* and *Calotropis procera* leaves against pathogenic isolates from motorcycle helmets in Lagos metropolis

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A B S T R A C T

Commercial motorcycle helmets have been identified as a possible vehicle for pathogen transmission. This study investigated the antimicrobial potential and minimum inhibitory concentrations (MICs) of aqueous, chloroform and ethanol extracts *of Jatropha curcas* and *Calotropis procera* leaves against *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Aspergillus niger*, *Penicillum fellutanum* and *Candida* sp. isolated from commercial motorcycle helmets in Lagos metropolis using agar well diffusion technique and the Clinical and Laboratory Standard Institute guidelines respectively. Aqueous and ethanol extracts of *C. procera* and *J. curcas* showed antimicrobial activity against almost all test isolates, while the chloroform extracts generally had lower antimicrobial activities. MICs of aqueous extracts of both plants was between 12.5 and 50 mg/ml of extract in all susceptible isolates, while MICs of ethanol extracts was between 12.5 and 100 mg/ml. The MICs of chloroform extracts was between 50 and 100 mg/ml for most test isolates, while failing to inhibit *S. aureus* and *E. coli* at the highest concentration tested. The ethanol extract of *C. procera* had the highest antimicrobial activity of all the extracts, indicating it is the most potent antimicrobials for motorcycle helmet disinfection.

K e y w o r d s

Motorcycle; Helmets; Antimicrobial; Microorganisms**;** *Jatropha curcas; Calotropis procera*

Introduction

The motorcycle is a popular means of transportation in most parts of Lagos, Nigeria (Adamu *et al*., 2012). Motorcyclists in the city of Lagos largely operate on a commercial basis and are patronized for reasons which include: ease of maneuvering through the regular traffic congestion characteristic of Lagos metropolis, ability to ply through roads and corners which are almost not

motorable and routes where there are no commercial buses plying (Banjo *et al*., 2011; Adamu *et al*., 2012). However, the high rate of motorcycle related accidents, injuries and sometimes deaths in Lagos, necessitated the enactment of the Nigerian crash helmet law which mandates the compulsory use of Motorcycle helmets (MCHs) (BBC News, 2009; Adamu *et al*., 2012). While the enactment of the crash helmet law is commendable, Adamu *et al.* (2012) reported that the sharing of MCHs amongst commuters could constitute a vehicle for the transmission of microorganisms of health importance, giving that the human body is colonized by a large microflora. Similarly, Roth and Jenner (1998) had also noted that the regular handling and use of MCHs could constitute a breeding ground for microbes. Thus there is need to regularly clean and disinfect MCHs with preferably, relatively affordable, environmentally friendly, acceptable and equally efficient antimicrobials in order to reduce if not eliminate pathogenic microbes that could harbour MCHs. The development of microbial antibiotic resistance has necessitated the global search for new antimicrobials of preferably plant origin (Pretorius *et al*., 2003; Aibinu *et al*., 2007; Jain *et al*., 2010). Plant extracts, and pure compounds isolated from natural sources have formed the bedrock of modern chemotherapy (Murti *et al.*, 2010). Various botanicals have been reported to have antimicrobial activity (Gubitz *et al.*, 1999; Mudi and Ibrahim, 2008; Parabia *et al*., 2008; Yemsin *et al*., 2008; Kamboj and Saluja, 2009; Arekemase, 2011; Taye *et al*., 2011; Afzal *et al*., 2012; Kanife *et al*., 2012). Worldwide, the number of plants with medicinal properties is quite vast (Chopra and Rajasekharan, 1958; Yemsin *et al*., 2008). *Jatropha curcas,* a tropical perennial plant belonging to the *Euphorbiaceae* family, is readily available in large amounts in Nigeria and have been reported to possess antiseptic properties (Gubitz *et al*., 1999; Kumar and Sharma, 2008; Warra, 2012). It contains a wide range of phytochemicals to which its antimicrobial effect is attributable (Arekemase, 2011; Namuli *et al*., 2011). Traditionally, parts of *J. curcas plant* have been used in the treatment of various forms of infections, including its use as an antiseptic during child birth and for the treatment of skin disease and sexually transmitted infections (STIs) (Gubitz *et al*., 1999; Namuli *et al*., 2011). *Calotropis procera*, belonging to the Asclepidaceae family, is a well known plant and has been traditionally used for the treatment of a wide range of infections globally (Raghubir *et al*., 1999; Alikhan and Khanum, 2005; Kumar and Arya, 2006; Kareem *et al*., 2008; Murti *et al*., 2010; Nenaah, 2013). The antimicrobial activity of *C. procera* plant extracts against bacteria and fungi is well documented (Adoun *et al*., 1997; Kareem *et al*., 2008; Kawo *et al*., 2009; Mako *et al*., 2012; Prabha and Vasantha, 2012; Saadabi *et al*., 2012; Nenaah, 2013). Nenaah (2013) reported that Gram-positive bacteria such as *Staphylococcus aureus* and *Bacillus subtilis* were more susceptible to *C. procera* solvent extract than the Gram-negative bacteria such as *Pseudomonas aeruginosa* and *Salmonella enteritidis* and that yeast species were more susceptible than the filamentous fungi. In another study, the ability of *Calotropis procera* to reduce total viable count of bacteria was reported by Shittu *et al*. (2004). Indications are that the extracts of these plants could be employed for the cleaning and disinfection of MCHs. Therefore, in a bid to source for relatively cheap and effective natural disinfectants for cleaning MCHs, this study investigated the *in vitro*

antimicrobial potentials of *J. curcas* and *C. procera* leaf extracts against potential pathogens isolated from MCHs with a view to also determining the most suitable solvent for extraction of the antimicrobial active ingredient .

Materials and Methods

Collection and preparation of plants

Fresh leaves of Swallow worth (*Calotropis procera*) and Physic nut (*Jatropha curcas)* were purchased from Oyingbo market in Lagos, Nigeria. Their identities were confirmed by the Herbarium Department of the University of Lagos. The plants leaves were cleaned, air-dried at room temperature (28 ± 2 °C), blended to powder and stored at room temperature in sterile bottles prior to use.

Preparation of Plant Extract

Excatly 100 g of the dried powder of each plant leaves was added to 300 ml each of ethanol, chloroform and water and allowed to stand for 3 days at room temperature (28 ± 2 °C), with agitations at intervals. Afterwards, each extract was sieved through a muslin cloth, filtered through a Whatman (No. 1) filter paper, concentrated and heat dried at 40 °C. The dried mass was stored in a sterile McCartney bottle and kept in the refrigerator at 4 °C until ready for use.

Sampling of Motorcycle helmets

Motorcycle helmets were randomly sampled from two locations in Lagos state the main gates of Yabatech and the Lagos State University Teaching Hospital (LUTH), where motorcyclists converge in large number to wait for prospective passengers. Sample size was as previously reported (Adamu *et al*. 2012).

Isolation and Identification of test Isolates

Microbial samples were collected by rotating a moist swab over the inner surface of the motorcycle helmets as reported by Gholamereza *et al*., (2009). Swabs were streaked on Nutrient agar (NA), MacCkonkey and Potato dextrose agar (PDA) plates. NA and MacCkonkey agar plates were incubated at 37 ºC for 24 h, while PDA plates were incubated at room temperature (28 ± 2 °C) for up to 72 h. Distinct colonies were picked and repeatedly subcultured to obtain pure cultures on respective growth medium, incubated at appropriate temperatures and duration. Bacterial cultures isolated were identified based on a combination of cultural, morphological characteristics (after Gram staining) and series of biochemical test, including, coagulase test, catalase test, indole production, citrate utilization, oxidase test and methyl red test. Fungi were identified on the basis of cultural and morphological characteristics as reported by Sampson *et al.* (1984).

Determination of Antimicrobial Activity

The Agar well diffusion method described by Pelczar *et al.*, (1993) was used to determine the antimicrobial activity of the plant leaf extract. Exactly 200 mg of each dried mass of leaf was added to 2 ml of solvents (aqueous, chloroform and ethanol). NA plates and PDA were seeded with 0.1 ml (1.0×10^4cfu/ml) of 24 h cultures of the test bacteria and fungi respectively. A 0.3 ml volume of each plant leaf extracts was dispensed into agar wells of diameter 6 mm. Reference drugs for bacteria and fungi, ciprofloxacin and ketaconazole respectively, in the same concentration as those of sample extracts served as positive control, while, each

solvent served as negative control. The cultures were allowed to stand for 1 h for the pre-diffusion of the extract to occur. Plates were incubated at conditions aforementioned. The zones of inhibition around the wells were measured using a ruler, and taken as an indication of antimicrobial activity. The experiment was carried out in duplicates.

Determination of Minimum Inhibitory Concentration

The minimum inhibitory concentrations of the plant extracts were determined according to the National Committee for Clinical Laboratory Standards (NCCL) (now known as the CLSI [Clinical and Laboratory Standards Institute] guidelines by doubling dilution method. To 4 ml of sterile nutrient broth in test tubes were added 4 ml of extract. Doubling dilution was done to have extract concentrations (in mg/ml) of 100, 50, 25, 12.5, and 6.25. Afterwards, 0.1 ml each of a 0.5 McFarland standard of the test organisms in normal saline (0.85% NaCl (w/v)) were inoculated into the test tubes and incubated at 37°C for 24 h. Potato dextrose broth was used for fungal isolates and incubated at 30 °C for 72 h. Controls were done by dispensing 4 ml of respective broth and 4 ml extracts without test organism into test tubes.

Result and Discussion

Pathogenic microorganisms isolated and identified in this study include *Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pyogenes*, *Aspergillus niger*, *Penicillium fellutan*, and *Candida* spp.

The antimicrobial activities of the aqueous leaf extracts of *Jatropha curcas* and *Calotropis procera* against test pathogens isolated from MCHs are shown in Table 1. The aqueous extract of both plant exhibited antimicrobial activity against all the test bacteria and fungi. The reference drugs exhibited higher antimicrobial activity against all the test isolates in comparison to the two aqueous leaf extracts. The aqueous extract of *Jatropha curcas* leaf particularly had higher antimicrobial activity against *A. niger* (15.5 mm) and *S. aureus* (15 mm) amongst other test isolate. The highest antimicrobial activity (14.50 mm) of aqueous extract of *C. procera* was recorded against *A. niger*. The aqueous extract of *C. procera* had the next highest (after the reference drug, ciprofloxin) antimicrobial activity against *Streptococcus pyogenes*. Generally (and in comparison between the two aqueous leaf extracts used), *C. procera* had higher antimicrobial activity against most of the test organism.

The antimicrobial activity of the ethanol extracts of *J curcas* and *C procera* against pathogenic microorganisms isolated from MCHs is presented in Table 2. Ethanol extract of *C. procera* and *J. curcas* leaves exhibited higher antimicrobial activity against all the test organisms than the control (ethanol). However, the control drug had higher antimicrobial activity than the ethanol extracts of the two plants against all test organisms. Ethanol extract of *J. curcas* had higher antimicrobial activity against *S. aureus* (15.5 mm), *A. niger* (13 mm) and *P. fellatum* (9.5 mm) than the ethanol extract of *C. procera*. However, the ethanol extract of *C. procera* had higher antimicrobial activity on the other three test organism (*E. coli*, *S. pyogenes* and *Candida* sp.) than that of *J. curcas*.

Table.1 Antimicrobial activity of aqueous extract of plant material on test microorganisms

Test organism	Zone of inhibition (mm)			
	J. curcas	*C. procera*	Water (control)	Ciprofloxin/ Ketaconazole
E. coli	12.50±0.10[a]	13.00±0.20[b]	-	18.40±0.40[c]
S. aureus	15.00±0.20[b]	13.50±0.30[a]	-	20.00±0.50[c]
S. pyogenes	11.50±0.50[a]	12.50±0.40[b]	-	25.50±0.10[c]
A. niger	15.50±0.10[b]	14.50±0.20[a]	-	18.50±0.30[c]
P. fellutanum	10.50±0.20[a]	13.50±0.50[b]	-	16.00±0.10[c]
Candida sp.	10.50±0.30[a]	12.50±0.20[b]	-	21.10±0.20[c]

Values are means ± standard deviation of duplicate determinations. Values with different superscripts on the same row are significantly different (P<0.05). -, no zone of inhibition; Ciprofloxin, positive control drug for bacteria; Ketaconazole, positive control drug for fungi

Table.2 Antimicrobial activity of ethanol extracts of plant material on test microorganisms

Test organism	Zones of inhibition (mm)			
	J. curcas	*C. procera*	Ethanol (Control)	Ciprofloxin/ Ketaconazole
E. coli	11.50±0.20[c]	14.20±0.10[b]	2.00±0.50[a]	18.50±0.40[d]
S. aureus	15.50±0.30[b]	15.00±0.20[b]	2.00±0.10[a]	20.00±0.50[c]
S. pyogenes	10.10±0.50[b]	16.40±0.40[c]	1.50±0.20[a]	25.00±0.10[d]
A. niger	13.00±0.10[c]	9.50±0.20[b]	1.50±0.40[a]	18.50±0.30[d]
P. fellutanum	9.50±0.20[c]	7.50±0.40[b]	1.00±0.50[a]	16.00±0.10[d]
Candida sp.	6.50±0.10[b]	7.50±0.30[c]	1.20±0.10[a]	21.00±0.20[d]

Values are means ± standard deviation of duplicate determinations. Values with different superscripts on the same row are significantly different (P<0.05). -, no zone of inhibition; Ciprofloxin, positive control drug for bacteria; Ketaconazole, positive control drug for fungi

Table.3 Antimicrobial activity of chloroform extracts of plant material on test microorganisms

Test organism	Zones of inhibition (mm)			
	J. curcas	*C. procera*	Chloroform (Control)	Ciprofloxin/ Ketaconazole
E. coli	-	7.00±0.50[a]	-	18.50±0.30[b]
S. aureus	-	-	-	20.00±0.50
S. pyogenes	6.00±0.30[a]	-	-	25.00±0.10[b]
A. niger	7.00±0.10[b]	7.00±0.20[b]	1.80±0.40[a]	18.50±0.30[c]
P. fellutanum	8.00±0.50[c]	7.00±0.10[b]	1.30±0.20[a]	16.00±0.10[d]
Candida sp.	7.00±0.20[b]	7.00±0.30[b]	1.00±0.50[b]	21.00±0.20[a]

Values are means ± standard deviation of duplicate determinations. Values with different superscripts on the same row are significantly different (P<0.05). -, no zone of inhibition Ciprofloxin, positive control drug for bacteria; Ketaconazole, positive control drug for fungi.

Presented in Table 3 are the antimicrobial activities of the chloroform extracts of the botanicals. Of the two chloroform extracts of the plants, only that of *C. procera* exhibited antimicrobial activity against *E. coli*. Similarly, only *J. curcas* exhibited antimicrobial activity against *S. pyogenes* of both chloroform extracts. None of the chloroform extracts (including the control, chloroform) inhibited the growth of *S. aureus*. All the chloroform extracts exhibited antimicrobial activities against *A. niger*, *P. fellutanum* and *Candida* sp. The control drug, ciprofloxacin had no activity against *E. coli.* While chloroform had no antimicrobial activity against *S. pyogenes*, the chloroform extract of *J. curcas* exhibited activity against *S. pyogenes*. The zones of inhibition (antimicrobial activity) values in all susceptible test microorganisms, were largely similar for the chloroform extracts of both plants.

The Minimum inhibitory concentration (MIC) of the plant extracts against the test isolates are shown in Table 4. *Caloptropis procera* extracts obtained from all the solvents studied showed antibacterial activity against test isolates at concentrations up to 12.5 mg/ml. The MIC of ethanol and aqueous extracts of *C. procera* against *S. aureus* were 25 mg/ml or less, while the chloroform extracts failed to inhibit the growth of *S. aureus* at the highest concentration tested (100 mg/ml). The MIC of the ethanol extracts of *C. procera* against *S. pyogenes* and *E. coli* was 50 mg/ml or less, while that against the fungal species; *A. niger*, *P. fellutanum* and *Candida* sp. was 100 mg/ml or less. Aqueous extracts of *C. procera* had a MIC of 50 mg/ml or less against almost all test isolates, with the exception of *S. aureus* and *A. niger*, where it found to be 25 mg/ml or less. The MIC of Chloroform extracts of *C. procera* against *S. pyogenes* and *S. aureus* appeared to be greater than 100 mg/ml (the concentration limit to which tests were conducted).

The MIC test of ethanol, aqueous and chloroform extracts of *Jatropha curcas* (Table 5) on test isolates generally showed that all the various solvent extracts, with the exception of chloroform extracts, had inhibitory activity against at least one test isolate within the various concentrations tested. While the MIC of ethanol and aqueous extract of *J. curcas* against *S. aureus* and *A. niger* was 25 mg/ml or less, that of *S. pyogenes* was 50 mg/ml or less. The highest MIC value for ethanol extract of *J. curcas* was against *P. fellutanum and Candida* sp., with a value of 100 mg/ml or less. The highest MIC value for the aqueous extract of *J. curcas* was 50mg/ml, and against *S. pyogenes*, E. coli, *P. fellutanum* and *Candida* sp. The MIC of chloroform extract of *J. curcas* was largely 100mg/ml for all test isolate, except for *S. aureus* and *E. coli*, where MIC appeared to be above 100 mg/ml.

The known pathogenic microorganisms isolated from MCHs are similar to that reported earlier (Adamu *et al*., 2012). This results which also corroborate the findings of Roth and Jenner (1998), further highlights the potential risk associated with sharing of commercial MCHs.

The antimicrobial activity and diameters of zones of inhibition ranges observed by the various botanicals used in this study are in agreement with and comparable to that of earlier reports (Gubitz *et al.*, 1999; Kumar and Arya, 2006; Kamboj and Saluja, 2009; Arekemase, 2011; Namuli *et al*., 2011; Afzal *et al*., 2012).

Table.4 Minimum inhibitory concentrations of *Calotropis procera* extracts on test bacterial and fungal isolates

Test isolates	Concentration of plant extract (mg/ml)														
	Ethanol					Water					Chloroform				
	6.25	12.5	25	50	100	6.25	12.5	25	50	100	6.25	12.5	25	50	100
S. pyogenes	+	+	+	-	-	+	+	+	-	-	+	+	+	+	+
S. aureus	+	+	-	-	-	+	+	-	-	-	+	+	+	+	+
E. coli	+	+	+	-	-	+	+	+	-	-	+	+	+	+	-
A. niger	+	+	+	+	-	+	+	-	-	-	+	+	+	+	-
P. fellutanum	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-
Candida sp.	+	+	+	-	-	+	+	+	-	-	+	+	+	+	-

+, presence of growth (no inhibition); -, no growth (presence of inhibition)

Table.5 Minimum inhibitory concentrations of *Jatropha curcas* extracts on test bacterial and fungal isolates

Test Organism	Concentration of plant extract (mg/ml)														
	Ethanol					Water					Chloroform				
	6.25	12.5	25	50	100	6.25	12.5	25	50	100	6.25	12.5	25	50	100
S. pyogenes	+	+	+	_	_	+	+	+	-	_	+	+	+	+	-
S. aureus	+	+	_	_	_	+	+	-	_	_	+	+	+	+	+
E. coli	+	+	+	_	_	+	+	+	-	-	+	+	+	+	+
A.niger	+	+	+	_	_	+	+	-	_	_	+	+	+	+	-
P. fellutanum	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-
Candida sp.	+	+	+	+	-	+	+	+	-	-	+	+	+	+	-

+, presence of growth (no inhibition); -, no growth (presence of inhibition)

The aqueous extract of *C. procera* exhibited antimicrobial activity against known pathogenic test isolates. The antimicrobial activity of aqueous extracts of the leaf, stem, latex, roots, apical twigs and fruits of *C. procera* against bacterial isolates including *E. coli*, *S. aureus*, *S. albus*, *P. aeruginosa*, *S. pyogenes*, *B. subtilis*, *Shigella dysenteriae*, *Vibro cholera* and *S. pneumonia* has been reported (Kareem *et al*., 2008; Parabia *et al*., 2008; Yemsin *et al*., 2008; Mako *et al*., 2012; Saadabi *et al*., 2012). The antimicrobial activity of *Calotropis procera* is attributable to the presence of bioactive compounds (Prabha and Vasantha, 2012). However, contrary to the findings of this study and earlier reports (Kareem *et al*., 2008; Yemsin *et al*., 2008; Mako *et al*., 2012; Saadabi *et al*., 2012). Kawo *et al*. (2009) reported that the aqueous extracts of *C. procera* leaf and latex failed to inhibit the growth of clinical isolates of *E. coli*, *S. aureus*, *Pseudomonas* sp. and *Salmonella* spp. The antifungal activity of aqueous extract of *C. procera* plant has also been reported in literature. Saadabi *et al*., (2012) reported that the

aqueous leaf extract of *C. procera* inhibited the growth of *Aspergillus flavus* and *Aspergillus niger*, while its aqueous stem extract inhibited the growth of *Candida albicans* and the aforementioned *Aspergillus* spp.

Previous studies have reported the antimicrobial activity and medicinal importance of *Jatropha curcas* plant parts (Igbinosa *et al*., 2009; Sharma *et al*., 2010; Arekemase, 2011; Narayani *et al*., 2012; Oloyede *et al*., 2012; Rachana *et al*., 2012; Omoregie and Folashade, 2013). Its antimicrobial activity has been attributed to the presence of certain pytochemicals which include saponins, tannins, alkaloids and glycosides (Arekemase, 2011; Namuli *et al*., 2011). The aqueous extract of *Jatropha curcas* leaf inhibited the growth of most test organisms, with the exception of *Candida* sp. Earlier, Arekemase (2011) reported that the latex of *J. curcas* inhibited the growth of *Candida albicans* at higher concentration of the latex, while the aqueous extract of *J. curcas* roots failed to inhibit the growth of *Candida albicans* at concentrations tested. He further reported that the aqueous root extract of *J. curcas* exhibited antimicrobial activity against a number of microbes including, *Neiserria gonorrhea*, *Escherichia coli*, *Staph. aureus*, *Pseudomonas aeruginosa* and *Aspergillus flavus.* Similarly, Igbinosa *et al*. (2009) reported the antimicrobial activity of stem bark aqueous extract of *J. curcas* against a wide range of bacterial isolates excluding *Klebsiella pneumonia*. In another study by Narayani *et al*. (2012), no antimicrobial activity against *E. coli*, *Proteus* sp., *S. aureus* and *P. aeruginosa* was observed from aqueous leaf extract of *J. curcas.* However, Oloyede *et al*. (2012) reported that aqueous extracts of *J. curcas* (up to a concentration of 500mg/ml) showed antimicrobial activity against *K. pneumonia*, *E. coli* and *P. aeruginosa.* The disparities in the different reports may be attributable to differences in extract preparation and concentrations, and as well as strain differences Microbial antibiotics sensitivity patterns have been reported to be strain-dependent within a given species (Kwon and Lu, 2007). For example, certain strains of *Staphylococcus aureus* are resistant to methilicin (Methicillin-resistant *Stapylococcus. aureus*, MRSA), whereas some are not.

The chloroform extracts of both plants have been reported to exhibit antibacterial and antifungal activities (Kareem *et al*., 2008; Prabha and Vasantha, 2012; Naranyi *et al*., 2012; Saadabi *et al*., 2012). Saadabi *et al*. (2012) observed that the chloroform extract of *C. procera* leaf had higher antimicrobial activity than the aqueous counterpart. They further reported that chloroform extract of *C. procera* leaf had particularly high antifungal activity against *Aspergillus flavus* and *Candida albicans.* The latex and chloroform extract of *C. procera* leaf showed antimicrobial activity against some clinical bacterial isolates by both paper disc and open well diffusion methods (Kareem *et al*., 2008). In a recent study, it was reported that chloroform extract of *J. curcas* showed very high antibacterial activity against *E.coli*, *S. aureus*. *Proteus* sp. and *P. aeruginosa* compared to other extracting solvents such as petroleum ether, methanol, acetone and water (Naranyi *et al*., 2012). Similarly, Mills-Roberson *et al*. (2012) reported that chloroform extract of *Cryptolepis sanguinolenta* inhibited the growth of test ATCC standard bacterial strains, including *S. aureus*, *S. saprophyticus*, *S. typhi*, *S. typhimurium*, *Proteus mirabilis*, *E. coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*

Ethanol extracts of *C. procera* leaf was reported to be the extracting solvent with the highest antimicrobial activity against clinical bacterial and fungal isolates (Kareem *et al.*, 2008). A similar observation was made in this study as the ethanol extracts of *C. procera* and *J. curcas* leaves had larger zones of inhibition in almost all the test isolates. During the screening of *J. curcas* root and latex for phytochemicals—which are responsible for antimicrobial activity, Arekemase (2011) observed that high levels of phytochemicals were detected in the ethanol extracts than in aqueous and hexane extracts. Similarly, a number of studies have also reported the antimicrobial efficacy of ethanol extracts of other plants (Cvetnic and Vladmir, 2004; Gotep, 2010; Lu *et al*., 2011; Malar *et al*., 2011; Meher, 2013; Wojtyczka, 2013).

The Minimum inhibitory concentrations (MICs) of solvent extracts against the test isolates in this study are comparable to other reports (Kareem *et al*., 2008; Arekemase, 2011). However, lower MICs values (0.5-1.0 mg/ml) were reported by Kawo *et al*. (2009) for ethanol extracts of *C. procera* leaf against *E. coli* and *S. aureus.* The reason for this slight discrepancy may be attributable to a possible difference in the characteristics of bacterial strains used and differences in plant species used. The same reasons may explain the lower MICs values reported by Igbinosa *et al*. (2009) for stem bark extracts of *J. curcas*. The MIC of ethanolic extracts of *C. procera* and *J. curcas* were the lowest of all the solvents' extract, implying that ethanol extracts were the most potent (at lower concentration) and that ethanol was the best extracting solvent. The lower the MIC of a botanical against pathogens, the more desirable it is.

This study has substantiated earlier reports of the presence of and possible transmission of microorganisms with health importance through sharing of Motorcycle helmets (MCHs). The antimicrobial potentials of solvent extracts of *Calotropis procera* and *Jatropha curcas* leaves for the disinfection of MCHs have also been demonstrated. The ethanol extract of *C. procera* had the highest antimicrobial activity against test pathogenic isolates. Further MCH-*in situ* studies using these extracts, which is on-going in our laboratory, would help determine the efficiency of applying these extracts to disinfect MCHs.

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